WASHINGTON
SCIENCE TRENDS

HIGHLIGHTS

- AIR FORCE PROGRAMS
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- BATTERY IMPROVEMENT NEEDS
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- PUBLICATION CHECKLIST

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* SPECIAL SUMMARY REPORT -- AIR FORCE PROGRAMS

The U. S. Air Force this week submitted to Congress its first official report on current and future programs of interest to research and development organizations. Here is a selective summary of key points, for guidance and future reference:

OPERATIONAL DEVELOPMENTS

ø Strategic Systems -- In the strategic systems area the primary objective has been to assure a proper mix between manned and unmanned systems so as to provide for a strong flexible deterrent posture in the future. The development of the ATLAS and TITAN I has progressed to a point of production and operational deployment. The problems relating to these two aspects have not been completely ones of development but have dealt with the transition to an operational role. A significant highlight of this program has the attainment by the ATLAS D of a 7200 statute mile range on the 9th of August and 22nd of October 1960 and a 9000 mile range on the 20th of May and 19th of September 1960. These four shots demonstrated the performance flexibility possible. The ATLAS has also been adopted as a first stage booster in most current space systems under development. The TITAN I has also shown considerable progress this past year, resulting in 13 successful and 3 partially successful shots out of 20.

"Second Generation" -- Substantial progress has been made in second generation ICBMs. TITAN II, with storable propellants, permitting faster reaction time, simplicity and improved hardening, has been approved for development and operational deployment. It has also been adopted for use as the first stage booster for DYNASOAR I. In the development of a solid propelled ICBM, an initial shot was considered an outstanding accomplishment in attaining complete success in the first test firing of the three-stage 60-foot, 65,000-pound solid propellant MINUTEMAN. The first launch on 1 February attained a range of 4600 statute miles approximately one year ahead of the originally estimated date.

Manned Aircraft -- The manned strategic force of the future is linked to the development of the B-70 bomber. This system is being developed to provide intercontinental range at Mach 3, and high altitude, with the capability of delivering a multiple load of high yield weapons. Some of the advantages provided will include target and weapon selectivity, recallability, damage assessment and recoverability. Appropriate subsystems have been initiated to phase in with the requirements of the development program. To increase the offensive capability of the B-52, which will be the backbone of the manned strategic forces for some time to come, the Skybolt air launched ballistic missile program was undertaken in 1959. This missile is progressing through its hardware stages and should be available for testing late this year. This system will enhance the useful life and capability of the B-52 for later time periods. (Continued)

* SPECIAL SUMMARY REPORT -- AIR FORCE PROGRAMS (Continued)

ø Air Defense -- Major emphasis during the past year has been placed on the attainment of systems to provide warning against any enemy attack. The most difficult is the detection and identification of ICBM attacks. In the past year our initial BMEWS station in Thule, Greenland has become operational and is now providing information to our continental command posts. Expedited efforts have been exerted to accelerate the attainment of an Initial Operating Capability at the Alaskan site by mid-year and at the United Kingdom site in early 1963. Developments have also been undertaken in the use of infra red detection techniques on orbiting vehicles to provide detection of ballistic missiles during the boost phase.

ø Tactical Systems -- Extensive studies have been completed which have provided necessary information and background to develop an operational requirement for a tactical fighter aircraft. The specific operational requirement for this tactical fighter has been established and is now in the process of being approved for source selection and subsequent development. Navy participation in the final review of the requirement has been solicited to insure that future naval applications for this type of system could be effected with minimal modification. This system is being developed to insure air superiority and air support in limited war situations. Its performance covers a wide spectrum of operating conditions, including a short take-off and landing capability and maximum flexibility for this very difficult mission.

In addition to the development of a tactical fighter for the limited war role, improved airlift capability has also been emphasized. Efforts have been initiated, not only to modernize our transport fleet by purchase of existing modern jet aircraft, but a requirement has also been developed and approved to provide the basis for the design and development of an advanced transport aircraft. Source selection is anticipated in early March. A tri-service effort was also initiated during this past year on a VTOL assault transport. The Department of Navy was selected as the systems development manager.

ø Command & Control & Support Systems -- Revolutionary advances in the destructive power of weapons and the speed and range of delivery systems have created a difficult problem in command. The extreme quantity and abstract quality of data, the compression of decision time, and the necessity for rigid central control to avoid accidents have imposed a severe problem upon the top commands. A vigorous approach to the development of modern command and control systems has been required. This general area of development was undertaken several years ago and has grown in complexity, scope and difficulty. The Air Force, recognizing this critical situation during the past year, initiated several studies, both by military operational groups, as well as the scientific, technical community to re-evaluate these problems in an attempt to focus our methods of approach and to seek better solutions.

The Becker Committee and the Winter Study Group both provided considerable insight into these development areas. The Air Research and Development Command has placed increased emphasis on the importance of command and control as an extremely important development area and is continuing to study and implement other recommendations for an effective approach to this difficult development field.

A listing of some of these important systems under development and a brief statement as to its status is given as follows:

* SPECIAL SUMMARY REPORT -- AIR FORCE PROGRAMS (Continued)

✓ 425L - We have continued the development program for our North American Air Defense Combat Operations Center. This will be an integrated combat operations center from which the Commander in Chief, NORAD, can direct and control the aerospace defense of the North American Continent.

✓ 438L - The Intelligence Data Handling System, required by SAC, North American Air Defense Combat Operations Center, Air Technical Intelligence Center, and the Air Force Intelligence Center is an integrated system for processing and delivering intelligence information by electronic techniques. We have continued our development of the system during this past year.

✓ 465L - We initiated the development and test of prototype equipment for the Strategic Air Command Control System at the contractor's facility.

✓ 480L - We have continued to modernize, expand, and augment with new techniques the present Air Force Communications System. This program is being accomplished on an evolutionary basis and is necessitated by the introduction into the Air Force of the various command and control systems and the voluminous data required by each; the compression of the reaction time as a result of ballistic missiles and the well publicized phenomena called nuclear black out.

✓ 496L - In October 1960 the DOD transferred responsibility for development and operation of Space Track to the Department of the Air Force. This system is being developed to detect, track, and catalog all earth satellites and space vehicles in orbit. During the past year an interim National Space Surveillance Control Center became operational at Hanscom Field, Massachusetts. Operational control for this system will be assumed by the Commander in Chief, North American Air Defense.

ø Operational Support -- The Operational Support Program includes miscellaneous equipments not identified with any specific system or mission. These are not weapon systems but are necessary for the support of various combat systems and have general application. A few examples of developments in this area are:

✓ An ultra violet altimeter for use on vehicles operating at altitudes up to 125,000 ft.;

✓ A carbon cloud decoy to confuse infra red guidance systems;

✓ An ophthalmic filter to control the transmission of light energy to provide protection for pilots' eyes while permitting optimum cockpit visibility under the wide range of operational conditions that may be encountered with future systems.

ADVANCED DEVELOPMENT

The advanced development area is the foundation of Air Force systems of the future. It is in this phase that we translate the results of applied and basic research efforts into integrated hardware, resulting in actual tests and demonstrations of the application of advanced technology for military purposes. These developments are not only critical building blocks in our development, but also result in the greatest expenditure of resources short of full weapon system development.

ø Saint -- In the past year it has become more evident that a requirement exists for being able to inspect satellite vehicles in space. We must be able to determine the characteristics and intent of any satellite launched. Saint is designed to meet this requirement. The first contract for this program was let in late 1960.

* SPECIAL SUMMARY REPORT -- AIR FORCE PROGRAMS (Continued)

ø Discoverer -- The purpose of the Discoverer program is to design, develop and flight test satellite vehicles. During 1960, 11 Discoverers were launched, 7 orbited successfully and in 4 cases, the capsule was recovered. In 3 of these instances, it was air snatched. The more powerful and guided Discoverer vehicles will fly equipment designed to collect background infra red information, continue testing of Agena components for other satellite programs, collect selected geophysical and biomedical data, and will further perfect the technique of reliable recovery of capsules of space vehicles.

ø Dynasoar -- The Dynasoar may be regarded as a logical follow-on to the X-15 in the exploration of aerospace. This military test system has a capability for manned, maneuverable, hypersonic re-entry from orbital altitudes and velocities with a normal landing at conventional air fields. It consists of a minimum sized delta winged glider which is boosted to near orbital speeds by a modified Titan II. From program approval in May, we have placed primary emphasis on trade-off studies, prosecution of development studies leading to a design configuration freeze early in 1961 and an analysis of ground support equipment and facilities requirements.

ø ANP -- Direct and Indirect Cycle Engines have been under concurrent development in the ANP program for some time. Considerable progress has been made on both cycles during the last year. Ceramic fuel elements and associated coatings are being developed and tested in a full-scale Direct Cycle reactor to insure a useful life and low fission product leakage. Progress on the Indirect Cycle has involved work on liquid metal pumps, oxidation resistant coatings and radiator developments. These all require further development and test to assure desired integrity. Technical assessments of these parallel approaches are made on a continuing basis. The "key question" in the selection of a direct or indirect cycle system is said to be "growth potential."

ø HETS -- The characteristics of an aerospace system are defined by its environments. As man with his machines enters a broader spectrum of performance, they encounter an entire new realm of environmental circumstances. Such considerations as cosmic radiation, meteoritic impact, high levels of acoustic energy, and the hazards of closed ecological systems have become paramount. The Air Force in close coordination with the NASA is developing an advanced version of the NASA Scout as a vehicle to lift experiments weighing from 25 to 1000 lbs. into this new environment. Testing subsystems in this manner should provide, at relatively moderate cost, needed design information for final military system configuration. The Hyper Environmental Test System, Blue Scout, will be completed in 1961. Of the two launches attempted through CY 60, one was successful.

ø Recoverable Boosters -- The cost of placing payloads in orbit is extremely high. We have been conducting studies to determine what means might be available to recover at least the first stage booster. We have considered such techniques as lifting surfaces, air snatch, rotating blades, etc. Next year, we plan to exert continued efforts in this direction so that we may obtain adequate results to form a basis of significant cost reduction in the future.

ø Development Support -- For some years now the Air Force has found it necessary to employ a group of contractors to assist it in the areas of technical direction and systems integration, advanced planning, analysis, space developments, and command and control. These contracts for technical assistance are normally placed with non-profit contractors such as Lincoln, Rand and Aerospace Corp.

* SPECIAL SUMMARY REPORT -- AIR FORCE PROGRAMS (Continued)

ø X-15 -- The joint Air Force-Navy-NASA program using the X-15 flying laboratory will be continued next year. The NASA-Air Force team established a new world's altitude record of 136,000 feet and attained a speed of 2196 MPH using the XLR-11 engine. This program was marred by an explosion while ground testing the XLR-99, 50,000 lb. variable thrust rocket engine. The number 3 aircraft suffered substantial but repairable damage. The number two aircraft now has installed the XLR-99 engine. Three flights have been accomplished limited to Mach 2.9 and 75,000 ft. This aircraft has a performance capability of Mach 6.5 and 250,000 ft. altitude.

RESEARCH PROGRAMS

It is rather difficult to plan or predict areas of applied research which will produce the maximum advances in our military technology. In an attempt to solve this difficult task the Air Force develops what it terms long range R&D objectives. These objectives are generated through careful, considerate examination by the technical and scientific community, industry and within the Air Force itself. Through the initiation of work statements to these various groups long range project study requirements are undertaken. A careful review produces a workable plan for identifying applied research tasks which should be undertaken today to provide necessary techniques and methology for the future. These projects are in essence an exploitation through application of basic knowledge to solve military problems.

A very recent example which the Air Force finds extremely interesting with many possible applications is substantial progress being made in hydrogen, ramjet and rocket technology. Certain proposed techniques, if proven practicable, may offer propulsive efficiences much greater than those achieved with the best boosters available today. We plan to identify applied research knowledge that must be obtained before a military application can be made. This program has recently been undertaken and is known as the Aerospace Advanced Propulsion Program.

Another program that is not quite as futuristic looking but was undertaken this past year is the Boundary Layer Control Program. This technique has been explored for some time and has reached a point where application of laminar flow boundary layer control to reduce drag is being attempted on a full scale aircraft. It is predicted that this technique should produce aircraft with considerable extended range and improved performance.

Other significant advances have been made in such items as the air bearing gyro, ion engine, Laser techniques, language translater and many more in the varied and important field of applied research.

Military departments have been for some time, are now and probably will continue to be, the greatest consumers of basic technology. The Air Force basic research effort is just a portion of the National research program. However, we find that we do not have the resources to apply to the whole area of basic research. We attempt to be selective and only probe those areas that are closely allied to our applied research program. To report any specific results in this area is very difficult. We can only state that our needs are continuing and that the program is being carried out by the most prominent scientists of this nation. Our primary intent is to provide selective support and encouragement in this very fruitful and essential fundamental effort.

* SERVICES SEEK IMPROVED BATTERIES

The military services continue to express a need for improved batteries as primary and auxiliary power sources in a variety of applications.

Among specific requirements:

✓ A battery that will provide 100 kilowatts for 15 minutes of torpedo propulsion with a rating of 500 watt-hours per pound, or 19 watt-hours per cubic inch.

✓ A battery that will provide 10 kilowatts for 15 minutes as a guided missile auxiliary power source, with a rating of 200 watt-hours per pound or 7.5 watt-hours per cubic inch.

The above requirements are said to be about 1000% higher than the capabilities of present-day units. A "good" present day unit such as the Mg, H_2O, AgU type will give approximately 22.4 watt-hours per pound, or 0.9 watt-hours per cubic inch. It is believed that progress in batteries for guided missile auxiliary power may come from current efforts in the development of ammonia vapor activated batteries, or some other high rate system.

Other Specific Requirements:

✓ A rugged dry cell capable of full capacity without activation after 10 years of shelf storage at temperatures of 120°F.

✓ A reduction in cost, volume and weight of all types of batteries, coupled with an increase in reliability of activation.

✓ A small, lightweight battery that will operate reliably over a temperature range of -65° F to 160° F. It must be capable of automatic activation without warmup time.

Will fuel cells do the job? -- The military comments that fuel cell type primary batteries show theoretical promise, but "it should be noted that any fuel cell is likely to have too long a startup time for most ordnance applications." Also, a fuel cell, capable of operation for any length of time would require considerable auxiliary equipment such as tanks and fuel lines.

Some problems -- Lead acid batteries, it is pointed out, are large, heavy and cheap but "not at all attractive for ordnance use" because power output tends to be low. Silver-zinc batteries are small and light but have a "relatively short shelf life after activation." While shelf life can be prolonged by unactivated storage, there is a need for immediately available power, without any attention whatsoever. Electrolyte storage outside the plate area has the disadvantage of increasing battery volume without increasing the output per cubic inch. Other drawbacks: Hardware associated with activation is heavy and often unreliable; gas must be bled off to obtain complete activation.

Sacrifice Performance? -- The military comments that reduction of cost, volume and weight do not go hand in hand with increased reliability. However, industry is advised that equal emphasis should be placed on decreased cost, increased reliability and increased shelf life -- even at the sacrifice of some performance.

"Deplorable!" -- That is the word used to describe the situation in obtaining high-power, efficient, long shelf life batteries at a cost in line with their basic expendable nature.

* GROUND EFFECT MACHINES -- The Navy would like to hear "as soon as possible" from organizations interested in the design, development and construction of a 20-ton hydroskimmer, a seagoing research craft for improving the state of the art and determining military applications. Write U. S. Navy, Bureau of Ships, Washington 25, D. C., ATTN: CODE 420.

* CONTROLLED FUSION RESEARCH -- SPECIAL SUMMARY

Here is a summary of recent progress and plans in controlled fusion research as reported during the past week by the U. S. Atomic Energy Commission:

✓ Progress Promising -- The AEC believes that the thermonuclear research program, directed toward the production of useful electric power from the atomic fusion of light elements, "made what appears to be promising progress this year." In particular, research at the Livermore Laboratories "looks good."

A variety of machines are being built, all of which are designed to hold ions of the light elements in a magnetic field and impart to them enough energy to make them fuse together to form heavier atoms with a release of considerable energy. This first step will have been achieved when investigators reach "ignition temperature" for a plasma of ions which is confined for a sufficiently long time at a high enough density.

"During 1960, the Commission states, "we came closer to this than ever before, using two stages of a proposed three stage magnetic compression machine. Some time this month or next month, we hope to try this machine with all three stages operating."

✓ Toy Top -- Last October, researchers at Livermore (University of California Radiation Laboratory) used two stages of a proposed three-stage compression machine to heat deuterium (heavy hydrogen) plasma to a temperature of about 30 million degrees C and to observe the stable confinement of this hot plasma for about one thousandth of a second. Mean energy of the ions was observed to be about 3,000 electron volts, which compares with the ideal ignition temperature for a deuterium-tritium reaction of 5,000 electron volts, and for a deuterium-deuterium reaction of about 40,000. The observed confinement time was roughly 1,000 times as long as that required for troublesome hydromagnetic instability to develop.

✓ Increased Energy -- At the time these experiments were performed an improved machine, Toy Top III, was not yet complete. Researchers are currently installing a third stage to provide additional magnetic heating and compression, with hopes that further experimental results can be obtained by the end of March, 1961, "if everything goes perfectly." It is expected that three-stage operation will provide a plasma in which the mean ion energy is increased to perhaps three times the level obtained in the two stage machine -- which "could be well into the range of temperatures at which thermonuclear reactions can occur."

✓ Increased Stability -- In addition to higher temperatures, researchers have hopes that they will be able to increase by several-fold the period during which the magnetic field strength is adequate to prevent plasma loss. If Toy Top III succeeds in maintaining stability of the higher temperature plasma, the next step would be to try to extend the period of plasma confinement in order to help assess the possibility of achieving a fusion reactor that will yield more power than it takes to operate.

✓ What is the Outlook? -- AEC advises Congress that "this is not the first time in the controlled thermonuclear field that we have had what seemed to be very promising results from our machines. And we have often been disappointed by further developments.

"However, all the experimental results observed from operation of the two-stage Toy Top have been consistent, and are in good agreement with predicted values.

"It looks good. We shall have to wait and see."

PUBLICATION CHECKLIST

- ☐ BRITISH GOVERNMENT RESEARCH REPORTS, the following research reports are now available at the prices stated from British Information Services, 45 Rockefeller Plaza, New York 20, New York:
  - ☐ Interferometry, proceedings of a symposium designed to provide an opportunity for physicists interested in metrology, optics, radio and radiation to meet and discuss recent developments. 470 Pages. $5.40.
  - ☐ Sound Absorbing Materials, a review by the U. K. National Physical Laboratory of the properties of various types of absorbents, describing their mode of action and indicating recent developments in design. 52 Pages. 55 Cents.
  - ☐ A Guide to Information on Atomic Energy in Britain, an attractive and useful publication listing British books, periodicals, reports, films, photographs and display material describing the latest nuclear developments of the U. K. Atomic Energy Authority. 64 Pages. 90 Cents.
  - ☐ Polystyrene Moldings, a Ministry of Aviation report of research to determine the behavior of plastics under tropical conditions. Ask for Report on Plastics in the Tropics No. 13. 42 Pages. 90 Cents.

- ☐ JOURNALS IN SCIENCE AND TECHNOLOGY -- Japan and Mainland China, a Library of Congress listing of Chinese and Japanese publications, with brief descriptions of each of 331 titles. Single copies free while limited supply lasts. (Write Science and Technology Division, Library of Congress, Washington 25, D. C.)

- ☐ RADIOISOTOPES RESEARCH AND DEVELOPMENT, a list of reports resulting from Atomic Energy Commission research and development contracts in this field. The availability of each report is noted. 18 Pages. Single Copies Free. (Write U. S. Atomic Energy Commission, Washington 25, D. C., ATTN: Office of Isotopes Development for "Reports Issued Under R&D Contracts")

- ☐ FEDERAL FUNDS FOR SCIENCE, detailed statistics on the Federal Government's research and development budget for the Fiscal Years 1959, 1960 and 1961. 89 Pages. 50 Cents. (Write Superintendent of Documents, Government Printing Office, Washington 25, D. C. for Publication NSF 60-80)

- ☐ LIQUID METALS CORROSION, a wide variety of information developed at a Government-sponsored meeting on liquid-metal technology as related to nuclear space-power systems. The principal considerations were liquid-metal corrosion, and the related areas of purification and chemical analysis. Covers both Government and industrial research. 109 Pages. Single Copies Free. (Write National Aeronautics and Space Administration, Washington 25, D. C., ATTN: CODEBID, for NASA Technical Note D-769)

- ☐ IMPACT OF AUTOMATION, a collection of 20 articles published over the past five years by the U. S. Department of Labor. 114 Pages. 60 Cents. (Write Superintendent of Documents, Government Printing Office, Washington 25, D. C. for Publication No. L 2.3:1287)

- ☐ NAVAL HYDRODYNAMICS, it took a few years but the proceedings of a 1958 international symposium on this subject are now available. Contains 26 technical papers and related discussions on various aspects of hydrodynamic noise and cavity flow. 583 Pages. $4. (Write Superintendent of Documents, Government Printing Office, Washington 25, D. C. for Publication No. D 210.15:ACR-38)